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(71) Applicant: Stichting voor de Technische Wetenschappen
Van Vollenhovenlaan 661 P.O. Box 3021
NL-3502 GA Utrecht(NL)

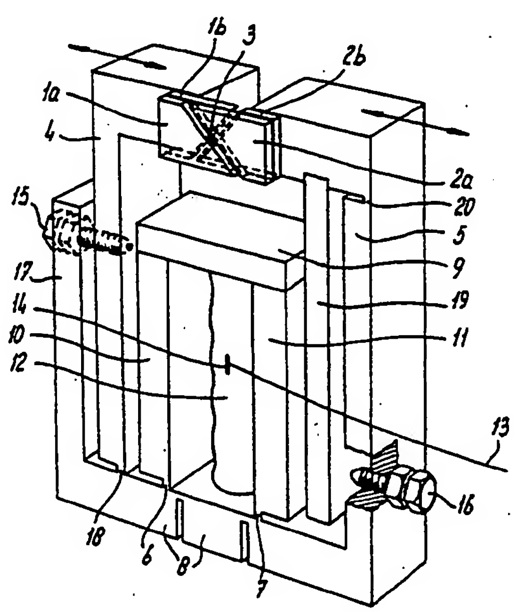
(72) Inventor: Brakenhoff, Godefridus Jacobus
Nieuwe Herengracht 79
NL-1011 RT Amsterdam(NL)

(74) Representative: Baarslag, Aldert D. et al
Nederlandsch Octrooibureau Johan de Wittlaan 15 P.O. Box 29720
NL-2502 LS Den Haag(NL)

(54) **Continuously variable microdiaphragm.**

(57) A continuously variable microdiaphragm has an aperture (3) of which the shape of the cross section remains the same when the aperture becomes greater or smaller. The aperture is lozenge-shaped and is bounded by two recesses each disposed in a separate diaphragm strip (1a, 1b; 2a, 2b). Each of these strips is fixed on or forms part of a transmission leg (4, 5, 30, 31). These legs can be shifted symmetrically relative to each other.

fig-1



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Continuously variable microdiaphragm.

The invention relates to a continuously variable microdiaphragm having an aperture between 0.5 and 1,000 µm.

In modern electron microscopes and scanning microscopes diaphragms with a specific measurement are used. For many applications, such as regulation of the lighting intensity from a laser and variation of the resolution, it is desirable to have a microdiaphragm with adjustable aperture available. One problem here is that the shape of the cross section of the aperture must remain the same when the aperture becomes greater or smaller. Moreover, it is not possible with the known designs of diaphragms to vary the aperture continuously to sizes of the order of 500 µm to 0.5 µm.

The invention provides the solution to this problem.

According to the invention, a lozenge-shaped aperture is bounded by two recesses, each disposed in a separate diaphragm strip, each of said strips being fixed on or forming part of a transmission leg, while means are present for shifting the transmission legs symmetrically relative to each other.

In principle, the recesses in each diaphragm strip could be lozenge-shaped, with the lozenges partially overlapping each other. However, it is simpler if the recesses are V-shaped and are disposed in the end edge of a diaphragm strip.

The cheapest and simplest design of each diaphragm strip consists of two plates which are fastened on each other and have slanting end edges, two slanting end edges lying behind one another always forming a V-shaped recess.

The lozenge-shaped aperture becomes larger or smaller when the transmission legs are moved a small distance apart or towards each other in a controlled manner. An accurate and controllable displacement of the transmission legs can be achieved if each of the legs is a U-shaped lever and these levers are symmetrically connected by means of a tilting point to a tilting mechanism.

The tilting mechanism preferably comprises a rectangular bar structure with a bottom bar, two uprights standing perpendicular to said bottom bar and connected thereto and to the levers by means of a tilting point, and a bridge piece connected to the uprights and running parallel to the bottom piece, while an expandable member is placed between bottom piece and bridge piece.

The expandable member could be, for example, a hydraulic cylinder or an electromagnet. A better solution is, however, a column of piezoelectric material which is connected to an electrical current source.

It must be possible to adjust the outlet size of the aperture. For that reason an adjusting screw is added to each U-shaped lever.

A second embodiment has the advantage that a relatively great displacement of the displacement means (drive unit) can be converted into a relatively small variation of the aperture. For this, the transmission legs are connected by means of hinges to the legs to which a drive unit is added and which are connected by means of hinges to a block.

This device can be made easily and cheaply through the transmission legs, the legs to which the drive unit has to be added and the block being made in one piece through the provision of slits.

The invention will now be explained in greater detail with reference to the figures in which two embodiments are shown.

Fig. 1 shows a perspective view of a first embodiment of the device according to the invention.

Fig. 2 shows a front view of part of said device.

Fig. 3 shows a top view.

Fig. 4 shows a front view of a second embodiment.

Fig. 5 is a section along the line V-V in Fig. 4.

The devices shown are microdiaphragms with an adjustable aperture (variable pinhole) the maximum dimensions of which lie between 0.5 and 1,000 µm. The devices can be used, inter alia, in scanning microscopes and electron microscopes, in particular to vary the intensity of a laser beam or to determine the size of an aperture for a detector. By regulating the beam widening, it is possible to vary the aperture of a lens used, and thus the resolution; with maximum resolution the light intensity through the lens can be controlled. It is important that on changing the dimensions of the aperture it retains the same shape. It is also possible to vary the detection resolution by varying such an aperture placed in front of a detector.

The two devices comprise two diaphragm strips, each in the form of a pair of plates 1a, 1b and 2a, 2b. Each of the plates has a slanting end edge, and in the example shown these edges form an angle of 45 and 135 degrees respectively with the longitudinal edges of the particular plate. The plates of each pair are bonded together and the slanting end edges together form an angle of 90 degrees. The arrangement shown produces a square aperture 3 whose shape remains square when the pairs of plates are shifted relative to each other. The angle of 45 degrees is not a determining

factor for the idea; it may also be another angle so long as the corresponding plates just connect together so that they are parallel and flat. A variable opening in another shape then results.

In the embodiment according to Figs. 1 to 3 each of the pairs of plates 1a, 1b, 2a, 2b is fixed to a U-shaped transmission lever 4, 5. Each of said levers is connected by means of a tilting point 6, 7 to a rectangular bar structure, comprising a bottom piece 8, a bridge piece 9 and two uprights 10, 11.

The drawing shows clearly that the levers 4, 5 and the bar structure 8, 9, 10, 11 are in one piece, and the tilting points 6, 7 are thinned parts of the material.

A member 12 which can expand and contract in a controlled manner is placed between the bottom piece 8 and the bridge piece 9. The member 12 is preferably a column of piezoelectric crystal tablets. A guide wire 13 extending from an electrical current source is soldered to the column 12 at 14. It is possible to control the length of the column accurately by varying the electrical current on the column 12. An expansion movement of the column leads to a tilting movement of the levers 4, 5 about the tilting points 6, 7 in a direction in which the pairs of plates 1a, 1b and 2a, 2b move towards each other and the aperture becomes smaller. A retracting movement of the column 12 will, of course, result in an enlargement of the aperture.

Other mechanisms could be used instead of the member 12, for example, an electromagnetic or hydraulic mechanism, but a piezoelectric column is preferable on account of its accurate adjustability over a small distance by means of electrical current.

At voltage 0 the size of the aperture will have to have a certain selected value, so the levers 4, 5 can be shifted by means of adjusting screws 15, 16. The adjusting screw 15 projects through a screw-threaded opening into an upright 17 which is integral with the bottom piece 8 and is connected by means of a tilting point 18 to the lever 4. The screw end engages with the lever 4.

The adjusting screw 16 projects through a screw-threaded opening into the lever 5; the end of said screw engages with a bar 19 which is only connected to the flange of the U-shaped lever on which the pair of plates 2a, 2b is bonded. This flange is also connected by means of a tilting point 20 to the flange of the lever 5 which runs parallel to the upright 11. It will be clear that if the adjusting screw 15 is screwed further into its opening, the lever 4 will be tilted in such a way about the tilting point 18 that the plates 1a, 1b are shifted towards the plates 2a, 2b. When the adjusting screw 15 is turned back, the elasticity of the material will cause the lever to move backwards in a direction in which the pair of plates 1a, 1b moves away from the pair of plates 2a, 2b.

Further screwing in of the screw 16 results in the top flange of the lever 5 being shifted at point 19 relative to the remainder of said lever. The pair of plates 2a, 2b will then move away from the pair of plates 1a, 1b. The outlet size of the aperture 3 can thus be accurately set with the screws 15, 16.

The symmetrical displacement of the pairs of plates 1a, 1b; 2a, 2b, and thus the size of the aperture, caused by the expansion and retracting of the column 12 can be very accurately controlled within narrow limits. The square shape of the aperture is retained. There is very great ease of operation. The pinhole can be increased and reduced entirely automatically in a simple manner. The design is therefore excellent for automatic exposure regulation and detector size regulation.

In the embodiment according to Figs. 4 and 5 the pairs of plates 1a, 1b and 2a, 2b are fixed to two legs 30, 31 which are connected by means of a hinge 32, 33 to two relatively long legs 34, 35 which are in turn connected by means of hinges 36, 37 to a block 38. Disposed at the free end of the legs 34 and 35 is a device 39, by means of which the legs 34, 35 can be moved apart and together in a controlled manner. This device 39 is, for example, an electromagnetic drive unit. The minimum distance between the legs 34 and 35 is determined by means of an adjusting screw 40. This prevents the plates from knocking against each other in such a way that damage occurs.

The distance between the legs 30 and 34 is determined by the adjusting screw 41 and that between the legs 31 and 35 by the adjusting screw 42. It will be clear that the relative displacement of the ends of the legs 34 and 35 is transferred in reduced fashion to the pairs of plates 1a, 1b, 2a, 2b, tilting taking plsce about the hinges 36 and 37.

The outlet size of the variable pinhole (aperture), i.e. the lozenge-shaped hole (square, rectangular) formed by the plates, can be adjusted by means of screws 41, 42, tilting taking place about the hinges 32, 33. The extent to which the movement of the unit 39 is transferred in reduced fashion to the pairs of plates can be varied by altering the position of the pairs of plates on the legs 30, 31 in the lengthwise direction thereof.

Since the drive unit makes a greater stroke than the envisaged alteration of the pinhole size, use can be made of a relatively simple electromagnetic drive instead of a piezoelectric drive. Apart from the drive unit, the device can be made in one piece by providing seven slits.

Various modifications are possible within the scope of the invention. The pairs of plates bound a lozenge-shaped aperture. Such an aperture could also be determined by a lozenge-shaped or V-shaped recess in two diaphragm strips. It is essen-

tial that the lozenge-shaped, preferably square opening 3 is bounded by recesses in a diaphragm strip and that said strips are fixed on or form part of legs which can be moved apart and towards other in a controlled manner.

Claims

1. Microdiaphragm having an adjustable aperture between 0.5 and 1,000 µm, characterized in that a lozenge-shaped opening (3) is bounded by two recesses, each disposed in a separate diaphragm strip (1a, 1b; 2a, 2b), each of said strips being fixed on or forming part of a transmission leg (4, 5, 30, 31), while means are present for shifting the transmission legs symmetrically relative to each other.

2. Microdiaphragm according to Claim 1, characterized in that the said recesses are V-shaped and are disposed in the end edge of a diaphragm strip (1a, 1b; 2a, 2b).

3. Microdiaphragm according to Claim 2, characterized in that each of the diaphragm strips is made up of two plates (1a, 1b; 2a, 2b) which are fastened on each other and have slanting end edges, two slanting end edges lying behind one another always forming a V-shaped recess.

4. Microdiaphragm according to one of the preceding claims, characterized in that each of the transmission legs (4, 5) is a U-shaped lever which is symmetrically connected by means of a tilting point (6, 7) to a tilting mechanism (8, 9, 10, 11).

5. Microdiaphragm according to Claim 4, characterized in that the tilting mechanism comprises a rectangular bar structure with a bottom bar (8), two uprights (10, 11) standing perpendicular to said bottom bar and connected thereto and to the levers by means of a tilting point (6, 7), and a bridge piece (9) connected to the uprights (10, 11) and running parallel to the bottom piece (8), while an expandable member (12) is placed between bottom piece (8) and bridge piece (9).

6. Microdiaphragm according to one of Claims 4 or 5, characterized in that an adjusting screw (15, 16) is added to each U-shaped lever (4, 5) to permit adjustment of the outlet size of the aperture (3).

7. Microdiaphragm according to Claim 5, characterized in that the expandable member (12) is a column of piezoelectrical material which is connected to an electrical current source.

8. Microdiaphragm according to one of Claims 1 to 3, characterized in that the transmission legs (30, 31) are connected by means of hinges (32, 33) to legs (34, 35) to which a drive unit (39) is added and which are connected by means of hinges (36, 37) to a block (38).

9. Microdiaphragm according to Claim 8, characterized in that the transmission legs (30, 31), the legs (34, 35) to which the drive unit (39) is added and the block (38) are made in one piece through the provision of slits.

fig-1

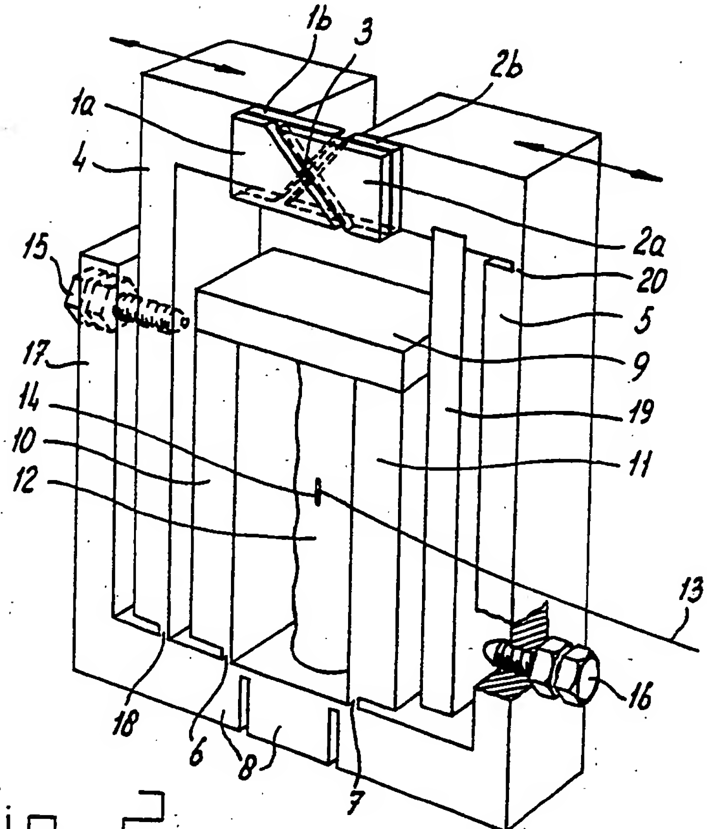

fig-2

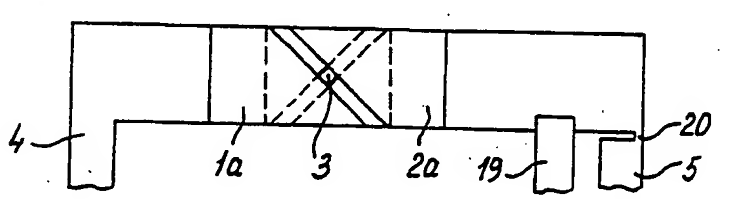

fig-3

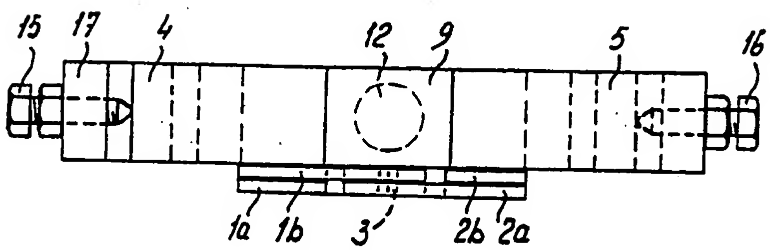

Fig-4

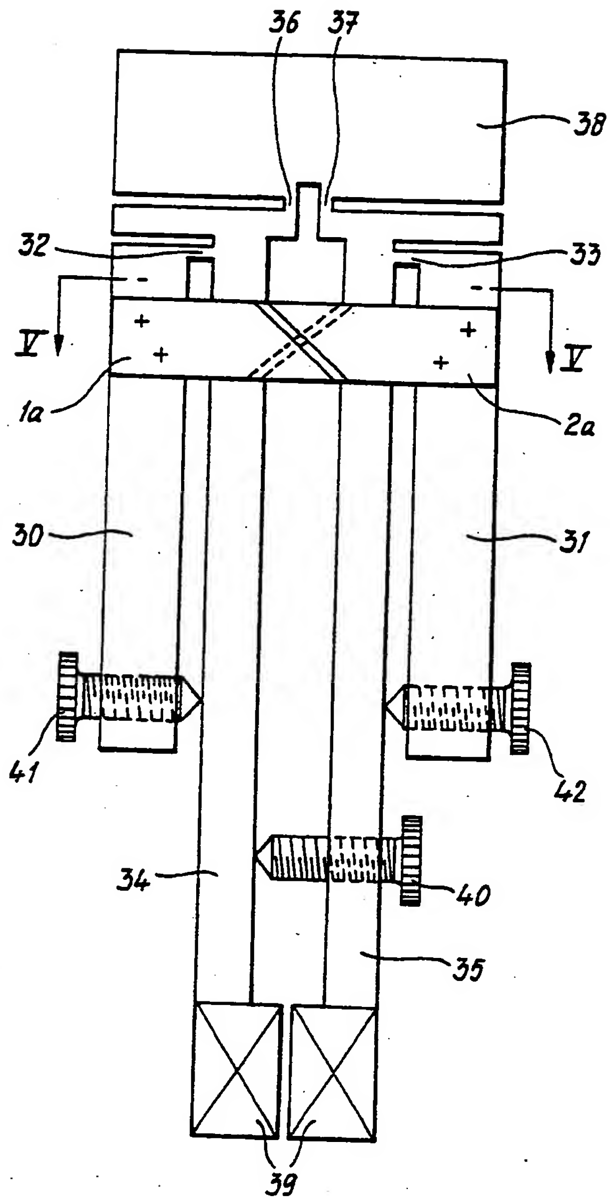
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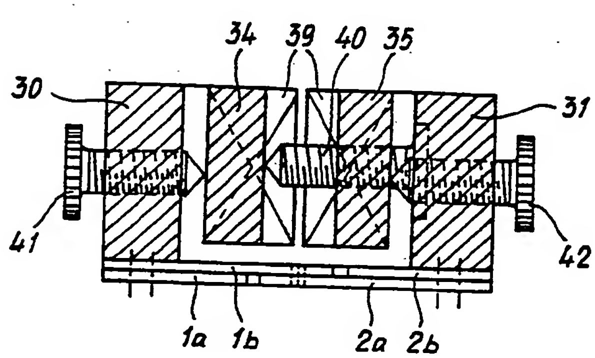
Fig-5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EUROPEAN SEARCH REPORT

Application Number

EP 88 20 0328

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A-2 146 790 (FINNIGAN MAT GmbH) * Figures 3-8; column 2, line 126 - column 4, line 46 * ---	1,7	H 01 J 37/09 G 02 B 5/00 G 21 K 1/04
X	DE-C- 891 583 (A.E.G.) * Figures 4-6; page 2, lines 90-121 * ---	1,2,4	
A	FR-A- 895 838 (FIDES) * Figure 3; page 5, left-hand column, lines 1-20 * ---	1,3	
A	US-A-3 610 734 (WOLLNIK) ---		
A	US-A-4 060 313 (KONDO) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 J 37/00
G 21 K 1/00
G 02 B 5/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-05-1988	SCHAUB G.G.

CATEGORY OF CITED DOCUMENTS

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